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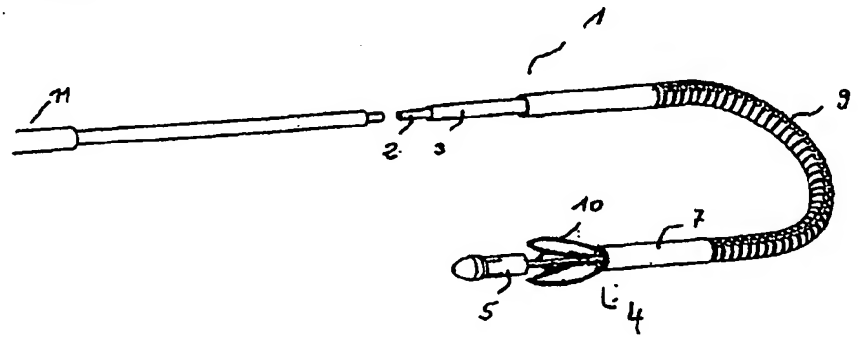
(54) Abstract Title: **Catheter for the transvascular implantation of prosthetic heart valves**

(57) The invention relates to a catheter for the transvascular implantation of prosthetic heart valves, in particular comprising self-expanding anchorage supports (10), which allow a minimally invasive implantation of prosthetic heart valves. The aim of the invention is to reduce the risk to the patient during the implantation. To achieve this, according to the invention a prosthetic heart valve comprising anchorage supports is temporarily housed in a folded form in a cartridge-type unit (4) during the implantation. The cartridge-type unit can be fixed on the proximal end of a guide system (1), which comprises a flexible region (9) that can be guided through the aorta. Actuating elements (2, 3) ran through the interior of the hollow guide system, said elements permitting sections of the cartridge-type unit to be displaced radially about their longitudinal axis and/or laterally in a proximal direction, thus allowing individual sections of the anchorage support and the associated prosthetic heart valve to be sequentially released.



This International Application has entered the National Phase Early.

GB 2 433 700 A

Catheter for the transvascular implantation of prosthetic heart valves

The invention relates to catheters for the transvascular implantation of prosthetic heart valves with self-expanding anchoring systems, by means of which prosthetic heart valves can be implanted with minimal invasion.

It is becoming more frequently necessary for an increasing number of patients to have prosthetic heart valves implanted, for which purpose both artificial and biological implants are used for heart valve prostheses.

In the past, such operations have been conducted in such a way that it as necessary to use a heart-lung machine on the anaesthetised patient. This therefore makes it a cost-intensive surgical intervention, which subjects the respective patients to a high degree of psychological and physical stress. The aim is to keep the lethality risk below 3%. As the age of the respective patients increases and impairment of the respective heart valves becomes more advanced, a situation is reached in which patients in need of actual treatment become inoperable. Since surgical valve replacement is not possible for these patients, they suffer from a reduce quality of life and have a considerably reduced life expectancy. Intervention would pose an extremely high risk.

These same issues also apply to operations whereby prosthetic heart valves with anchoring systems are implanted by means of so-called balloon catheters.

In a procedure of this type, incorrect positioning can occur,

which can have considerable consequences for the patient, possibly leading to the death of the respective patient.

In recent times, therefore, attempts have been made to implant heart valve prostheses by means of intervention methods involving minimal invasion, whereby such prostheses are fed together with an anchoring support via the aorta of a patient and through the aorta to the heart. On reaching the implantation site at the heart, self-expansion of such anchoring supports with a heart valve prosthesis attached to them is initiated, the intended result being a reliable anchoring and exact positioning of the heart valve prosthesis. Such anchoring supports have tended to be made from shape memory alloys, such as "Nitinol" for example, and the alloy is selected so that its transition temperature is around 37°C, and self-expansion can be initiated on reaching the transition temperature.

As a result of such expansion, the anchoring support opens up so that it is able to lie against the aorta wall, where it can be securely fixed by means of additional barb elements if necessary. The heart valve prosthesis is folded open simultaneously, so that it is able to assume its function.

An anchoring support of this type incorporating a heart valve prosthesis is described in patent specification WO 2004/019825 A1, for example.

Support hoops are provided at the proximal end of such an anchoring support, which can be introduced into the pockets of a patient's heart valve, thereby enabling the anchoring support to be very accurately positioned by means of these support hoops during a surgical intervention. What are referred to as commissural hoops are provided on this anchoring support in addition, which, together with the

support hoops, clamp parts of a patient's old heart valve once the anchoring support has unfolded so that the anchoring support can be reliably positioned and secured as a result of this clamping effect.

The support and commissural hoops of this known anchoring support should therefore be disposed and dimensioned so that they permit a sequential self-expansion. This means that the anchoring support is accommodated inside a cartridge for the implantation procedure. It is then fed by means of a catheter through the aorta as far as the diseased heart. On reaching the implantation site, the cartridge is manipulated so that the support hoops are released to allow them to self-expand. The cartridge is then moved and oriented together with the anchoring support so that the support hoops are introduced into the pockets of the heart valve of the respective patient. This enables exact positioning to be achieved.

The respective cartridge is then further manipulated, so that the commissural hoops are also released and able to self-expand. As this happens, the old heart valve is clamped between the support and commissural hoops and the heart valve prosthesis is opened up into its unfolded functional position.

After implanting the anchoring support incorporating the heart valve prosthesis, the catheter can then be removed from the patient's body together with the cartridge through the aorta.

Although the support hoops provided on the anchoring support can result in significantly easier and better positioning of the heart valve prosthesis to be implanted in the manner described above, there is a possibility of incorrect implantation and the heart valve prosthesis may not be capable of functioning or may be so to only an unsatisfactory degree. In certain situations, it is then no longer possible to remove

a non-functioning or unsatisfactorily functioning heart valve prosthesis and it poses an increased risk of mortality for the respective patient in some cases.

The bend in the aorta in the human body during introduction through the aorta poses another problem during such surgical interventions. As the cartridge and the respective catheter are moved during this procedure, a change of direction of approximately 180° with a relatively small radius of about 50 mm has to be negotiated without causing damage to the vessel wall.

Accordingly, the objective of the invention is to reduce risk to the patient during implantation of prosthetic heart valves.

This objective is achieved by the invention on the basis of a catheter incorporating the characterising features defined in claim 1. Advantageous embodiments and designs of the invention may be obtained on the basis of the characterising features defined in the dependent claims.

In a preferred embodiment, a catheter proposed by the invention may be used in conjunction with a heart valve prosthesis with a self-expanding anchoring support of the type known from patent specification WO 2004/019825 and the disclosed contents are included herein by way of reference.

This being the case, the anchoring support with the heart valve prosthesis attached to it can be temporarily accommodated inside a cartridge unit in a collapsed state during the implantation.

A cartridge unit prepared in this manner can be releasably attached to the proximal end of a guide system. The cartridge unit and guide system are minimised in term of their external

diameter to the degree that they can be fed through an aorta of a patient to be operated on without any difficulty, and to this end, the total free cross-section available inside the aorta should not be completely filled.

The guide system used is sufficiently long in terms of its length for the cartridge unit to be fed with the guide system by introducing it into the groin of a patient, through the aorta as far as the patient's heart.

A flexible, bendable region is provided on the guide system, by means of which a bending radius and bending angle can be achieved that will follow and make allowance for the bend in the patient's aorta.

Elements for operating the cartridge unit are fed by means of the guide system, which has a hollow interior. These operating elements enable parts of the cartridge unit to be manipulated and moved in a specific way. For example, a radial or also lateral movement of parts of the cartridge unit can be effected by means of the operating elements. Moving parts of the cartridge unit in this specific way enables parts of the anchoring support to be released in sequence so that implantation and anchoring can take place in the manner described in WO 2004/019825.

For example, support hoops of an anchoring support can be released by a rotation or by a lateral movement in the proximal or distal direction of a part of the cartridge unit, but other parts, such as the commissural hoops for example, continue to be retained inside the cartridge unit in the collapsed state, which can subsequently be released with a view to expansion by moving another part of the cartridge unit accordingly or by continuing the movement of the same part of the cartridge unit which previously still enabled the support

hoops to be retained inside the cartridge unit in the collapsed state.

The heart valve prosthesis, which is attached to the anchoring support by stitching for example, opens simultaneously as the respective hoops of the anchoring support, to which the heart valve prosthesis is attached, expand.

In a preferred embodiment, in addition to the operating elements for parts of the cartridge unit, other operating elements are fed through the internally hollow guide system, which act on the bendable region in order to influence its curvature in a specific manner.

Due in particular to traction forces triggered via the operating elements, a specific curvature of the bendable region can be achieved during the implantation on penetrating the bend of the aorta. Tension cables or tension wires may be used as the operating elements, which are run through the internally hollow guide system as far as the proximal edge of the bendable region, where they are secured on the guide system, in which case the attacking points of the force of two such operating elements should be disposed diametrically opposite one another and in addition should be disposed at 90° with respect to the bending axis about which the bendable region is required to curve.

For example, the curvature of the bendable region can be influenced in a specific way by applying a traction force via one of the operating elements as the guide system is pushed through the bend in the aorta by means of the bendable region and pulled out of it once the implantation has been completed.

The bendable region of a guide system may be provided in the form of a link chain, in which the individual links are

connected to one another by individual joints. This being the case, the individual joints positively engage in respective adjacent links. They are designed so that a curvature of more than 180° can be maintained in the bending region, with a bending radius which guarantees that at least the radius of the bend in the aorta can be achieved.

The individual joints on the individual links of a link chain should also be disposed diametrically opposite one another in pairs on the individual links and parallel with the rotation axis of the bendable region.

The guide system used with a catheter proposed by the invention should advantageously also be designed so that a liquid coolant or a pharmaceutical preparation can be circulated through the internally hollow guide system as far as the cartridge unit. With the aid of such a liquid coolant, for example a salt solution, the anchoring support can be kept below the transition temperature of the shape memory alloy. This also prevents body fluids from being able to penetrate the interior of the guide system and a liquid pressure should therefore be maintained which lends a sufficiently high resistance to penetration by body fluid or other elements contained in body fluid.

Introducing liquid coolant in an appropriate manner can also prevent gas, for example air, from getting into the aorta and the blood.

To this end, the entire guide system should be as liquid-proof as possible. Accordingly, a flexible, bendable region provided in the form of a link chain in this instance may be sealed from the outside by means of a plastic hose to render it liquid-proof.

The parts of the cartridge unit which can be moved in a specific way in order to release hoops of the anchoring support are preferably provided in the form of sleeve-shaped elements, the internal and external diameters of which are adapted to one another so that they can engage in one another telescopically, and at least two of the sleeve-shaped elements have mutually adapted internal and external diameters such that a collapsed anchoring support with heart valve prosthesis can be accommodated between them and retained in the collapsed state.

When introducing the catheter, the cartridge unit should be completely closed as far as possible and to facilitate introduction through the aorta should have a tip at its proximal end, which is in turn preferably made from a flexible material, for example silicone.

When the cartridge unit reaches the respective patient's heart, the appropriate manipulation can then be performed, in other words parts/sleeve-shaped elements of the cartridge unit moved, so that the different hoops of the anchoring support are sequentially released and the heart valve prosthesis secured to them simultaneously opened up.

As this happens, however, the anchoring support is still securely retained on the cartridge unit. To this end, anchoring elements are provided on one sleeve-shaped element of the cartridge unit, disposed at the distal end, for example at a point where eyes are provided on the anchoring support. In this position, these anchoring elements together with the distal part of the anchoring support are also covered by a sleeve-shaped element of the cartridge unit, so that the distal part of the anchoring element is still retained in the collapsed state.

In this position, it is possible to check the function of the heart valve prosthesis, which has already unfolded. Once it is evident that the heart valve prosthesis is functioning, a further manipulation may be effected by moving the sleeve element that was previously covering the anchoring element with the distal part of the anchoring support accordingly, which causes the distal part of the anchoring support to be fully released as well so that it can then fully unfold.

If, on checking, it is found that the implanted heart valve prosthesis is not fulfilling its function or is so but not satisfactorily, it is advantageously possible to move the anchoring support together with the heart valve prosthesis back into the cartridge unit by moving the parts/sleeve-shaped elements in the opposite direction accordingly and removing all the parts, in other words the entire catheter, from the patient's body again, thereby significantly reducing the risk of the operation, after which a further attempt at implantation can be made on the same patient.

In one advantageous embodiment of the catheter proposed by the invention, a guide wire can also be run through the entire catheter. Such guide wires are already used for operations of this type and they are fed through the patient's aorta to a point behind the heart before introducing the catheter. The catheter can then be placed over the cartridge unit and guide system and into the guide wire and pushed in along it into the aorta as far as the patient's heart.

In order to monitor the process of introducing the catheter and also manipulation of the bendable region, in particular at the bend of the aorta, it is of advantage to provide marker elements on the guide system and/or the cartridge unit, made from a material which absorbs X-radiation, so that the respective position can be pinpointed on an X-ray image during

the operation.

A screen filter may also be used with the catheter proposed by the invention, by means of which particles can be prevented from penetrating the respective patient's blood circulation system. Such a screen filter may be attached to the guide system so that it completely surrounds it in the radial direction. In this respect, it should be elastically biased so that it lies against the vessel wall of the aorta, thereby guaranteeing a closure that is impermeable to particles.

Furthermore, the catheter proposed by the invention may additionally be provided with a conventional balloon disposed in the interior of the guide system or cartridge unit and carried with it there or alternatively it can be fed through the interior of the guide system as far as the anchoring support to be expanded. Using such a balloon, the volume of which can be increased by means of a fluid at increased pressure, will further assist expansion of the anchoring support.

The operating elements described above, which may be fed through the interior of the guide system and provided in the form of traction and compression means, may advantageously be manipulated from a manipulating part. The manipulating part may be designed as a handle, by means of which the movement for introducing the catheter can then be effected by the respective surgeon.

Other control elements are also provided on such a manipulating part, by means of which the respective movement of the operating elements can be initiated. This being the case, it should be possible to effect the corresponding movement in as measured a manner as possible, for example with appropriate translation ratios, and it should be possible to

restrict the respective movement by end stops or catch positions at least. This enables specific maximum distances or angles to be preserved, for which allowance can be made in achieving the sequential expansion of the anchoring support or the specific way in which the curvature of the bendable region is influenced. In this respect, it should be possible to adjust the end stops or individual catches as finely as possible.

All the parts of a catheter proposed by the invention but at least those which come into direct contact with the respective patient and are also introduced into the aorta should be made from bio-compatible materials which are compatible with the respective organism. It should also be possible to sterilise them, in which case it should be possible to use one of the standard sterilisation processes.

The invention will be explained in more detail on the basis of examples.

Of the drawings:

Figures 1 to 4 are schematic diagrams illustrating an example of a catheter proposed by the invention during different possible phases of an implantation procedure;

Figure 5 shows an example of a catheter with a manipulating part and

Figure 6 is an exploded diagram illustrating the manipulating part illustrated in Figure 5.

Figures 1 to 4 are intended to illustrate and provide a clearer understanding of an example of a catheter proposed by

the invention. The individual diagrams illustrate different phases which take place during implantation of an anchoring support 10 incorporating a heart valve prosthesis.

The example of a catheter proposed by the invention illustrated in Figure 1 is shown with the cartridge unit 4, which is still completely closed, containing an anchoring support 10 incorporating a heart valve prosthesis in the non-expanded state and thus collapsed, so that it can be fed by means of the internally hollow guide system 1 through an appropriate access into the aorta and through it to the respective implantation site on the patient's heart.

Proximally disposed on the cartridge unit 4 is a flexible tip made from silicone, which facilitates the introduction procedure and reduces the risk of damage.

Part 5 of the cartridge unit is releasably connected to the other parts of the guide system 1, for example by means of a screw connection.

Adjoining the cartridge unit 4 is a bendable region 9, which is designed and dimensioned so that it is guaranteed to be able to move through the bend of a patient's aorta without causing problems.

Possible designs of such a bendable region 9 will be explained below.

Other parts of the internally hollow guide system 1 are also illustrated and Figures 1 to 4 show two operating elements 2 and 3 running through the guide system 1 as far as the cartridge unit 4, and in this instance the operating element 2 likewise runs through the internally hollow operating element 3 as far as the cartridge unit 4.

The operating elements 2 and 3 in this instance are provided in the form of lengths of compression spring, which are preferably reinforced by means of tension wire. Such tension wires make the catheter safer as it is being removed from the patient's body once the operation is complete.

Other parts 11 of the guide system 1 are illustrated on the left-hand side, which may be provided in the form of more or fewer sleeve-shaped parts, although these must be secured so that they are sufficiently pressure- and tension-resistant to withstand introduction into the aorta and extraction from the aorta again. Appropriately stiff plastic hoses may be used for this purpose, for example PTFE hoses or hoses with a PTFE base, because they are sufficiently compatible with the organism and can also be sterilised.

Figure 2 illustrates the procedure which takes place during a first stage of the operation on reaching the implantation site on the respective patient's heart. The part/sleeve-shaped element 7 of the cartridge unit 4 can be pulled back in the distal direction by a distal movement of one of the operating elements 2 and/or 3 so that some hoops of the anchoring support 10, for example and preferably the support hoops provided on the known heart valve prosthesis disclosed in WO 2004/019825 A1, expand and are biased radially outwards.

The entire catheter with the guide system 1 and the cartridge unit 4 can therefore be pushed proximally and these hoops (support hoops) introduced into the pockets of the patient's old heart valve. When the surgeon feels a perceptible resistance, the process of introducing the support hoops of the anchoring support 10 into the pockets of the old heart valve is complete.

The part/sleeve-shaped element 5 of the cartridge unit 4 can then be moved distally forwards, so that other hoops of the anchoring support can then also be released so that they can self-expand and open up the heart valve prosthesis.

A preliminary stage of this is illustrated in Figure 3, where a heart valve prosthesis has not yet been fully unfolded and the anchoring support 10 can also not yet be fully anchored.

As also illustrated in Figure 3, a distal part of the anchoring support 10 is still accommodated inside the cartridge unit 4, underneath the part/sleeve-shaped element 7 in the cartridge unit 4. This remains the case until the process of unfolding and positioning the heart valve prosthesis has reached the stage where its functionality can be checked.

If the check reveals incorrect functioning or faulty positioning, the part/sleeve-shaped element 7 can be pushed proximally again by one of the two operating elements 2 or 3 so that the anchoring support 10 with the heart valve prosthesis is at east partially accommodated in the cartridge unit 4 again and then the entire catheter can be removed from the patient by pulling it out of the aorta without causing damage to the vessel wall.

If the function test reveals that the heart valve prosthesis is able to fulfil its function to at least a sufficient capacity, the part/sleeve-shaped element 7 may be moved distally back, as illustrated in Figure 4, or another part/sleeve-shaped element 6 of the cartridge unit 4 may be pushed in the proximal direction so that the distal part of the anchoring support 10 can also be released and expand fully.

As also illustrated in Figure 4, eyes or other appropriate elements are provided at distal end regions of the anchoring support 10, which were previously engaged in anchoring elements 8 provided on the part/sleeve-shaped element 6. These eyes and the anchoring elements 8 ensure reliable retraction or extraction if it is established that an anchoring support 10 incorporating a heart valve prosthesis has been incorrectly or badly implanted, enabling the anchoring support 10 and heart valve prosthesis to be removed from the patient's body.

By means of the anchoring elements 8 as well as other guide elements 16 which may optionally be provided on the part/sleeve-shaped element 6 of the cartridge unit 4, it is also possible to effect a radial turning movement to enable the hoops of an anchoring support 10 to be introduced into the pockets of an old heart valve prosthesis in an exactly correct angular position, for example, in which case the entire catheter can be turned slightly about its longitudinal axis by the surgeon during the implantation.

Detail A of Figure 4 also specifically illustrates a cannula 12, which is fed through the cartridge unit 4 along its longitudinal axis. By mans of the cannula 4, the guide wire described in the general part of the description can be fed through cartridge unit 4.

Figure 5 illustrates an example of a catheter with an additional manipulating part 13, on which other control elements are provided in order to permit manipulation.

The guide system 1 together with the cartridge unit 4 described above with reference to Figures 1 to 4 are also used in this example.

However, detail A illustrates one possible design of the

bendable region 9 in the form of a link chain.

The individual links 9.1 are generally of the same shape and dimension.

In this respect, the oppositely lying end faces of the individual links 9.1 are shaped so as to form individual joints 9.2, each of which positively engages in adjacent individual links 9.1 and as a result of gaps with a sufficient gap width between the individual links 9.1 respectively ensure that the bendable region bends about at least 180° as mentioned above, with a radius of approximately 50 mm.

The individual joints 9.2 are formed by a cut-out in the respective oppositely lying end faces of the individual links 9.1, whereby a co-operating cut-out on one end face and a co-operating rounded, complementary protruding area on the diametrically opposite end face of the individual links 9.1 form the individual joints 9.2 on respective adjacent individual links 9.1.

Although not illustrated, the bendable region 9 may be enclosed by a plastic hose to render it fluid-tight.

Figure 5 also illustrates how a manipulating part 13 may be provided to enable a catheter proposed by the invention to be introduced and manipulated.

A handle 13.1 is provided for introducing and extracting the catheter with the guide system 1 and cartridge unit 4.

A fluid-tight closure in the form of a plate 17 is provided in the proximal part of the manipulating part 13, enabling the guide system 1 to be flange-mounted by means of a locking nut 23, and seal elements are provided, although these are not

illustrated here.

A standard Luer connection 30 is also provided, by means of which the coolant liquid can be circulated.

The respective curvature of the bendable region 9 can be obtained using the handle 19, which can be turned about an axis by means of tension cables (not illustrated) and this will be further explained with the description of Figure 6.

The entire manipulating part 13 should be sealed with respect to the surrounding environment and with respect to the guide system 1 so that it is as far as possible fluid-tight and also gas-tight if necessary.

The tube 28 can be moved laterally in the proximal direction by means of the lever 20 acting on the handle 13.1, and the corresponding movement and resultant traction or compression force transmitted to one of the two operating elements 2 and/or 3, thereby enabling a manipulation of the individual parts/sleeve-shaped elements 5, 6 and/or 7 of the cartridge unit 4 in the manner described above, for example in finely measured doses via the pumping movements of the lever 20.

The pushing handle 25 enables the position of part 5 of the cartridge unit 4 to be manipulated relative to the sleeve-shaped part 6 of the cartridge unit 4 in the extension beyond the length of spring by means of the fixing hooks, serving as anchoring elements 8. The pushing handle 25 is latched in a thread-shaped toothing 28.1 of a tube 28 by means of a compression spring. As a result, the pushing handle 25 follows the proximal movement of the tube 28, which is connected to part 6 of the cartridge via the length of spring serving as an operating element 3.

On reaching an end stop marking the first discharge stage, the pushing handle 25 can be turned in order to effect a finely measured axial displacement of part 5 of the cartridge unit 4 relative to part 6 of the cartridge unit 4 in the direction of the pitch of the thread 28.1.

With respect to operating the pushing handle 25, the latter is able to move the part 5 of the cartridge unit 4 illustrated here without an additional fine adjustment.

Such a manipulation enables the anchoring support 10 to be released (see Figure 3) and in this position, the anchoring support 10 can still be retracted.

When the stop 29 is released by means of an actuator member 31 provided in the form of an adjusting screw for example, the cartridge unit 4 may be extracted farther by operating the lever system 20 in the manner described above until the retaining eyes of the anchoring support 10 have moved away from the cartridge unit 4 and the anchoring support 10 is able to spring away from the anchoring elements 8 due to its expansion forces.

The elements of the cartridge unit 4 may be pulled back in stages. This being the case, part 5 of the cartridge unit 4 may be retracted by pulling back the pushing handle 25 (pushing element latched) beyond part 6 of the cartridge unit 4.

By operating a releasing bolt 32, part 6 of the cartridge unit 4 connected to the tube 28 can also be returned to its initial position by pulling the pushing handle 25 farther back so that the cartridge unit 4 is then completely closed again. In this state, the catheter can be removed from the patient's body again.

Figure 6 is an exploded diagram providing a more detailed illustration of the manipulating part 13 used in this example.

As illustrated, when the handwheel 19 is turned via the shaft 14, two toothed racks 24 oriented parallel with one another can be displaced. Accordingly, one toothed rack 24 is moved in the proximal direction as the toothed rack 24 oriented parallel with it is moved in the distal direction.

Although these are not illustrated here, tension cables may be secured to clamping jaws 21 acting on the co-operating toothed racks 24, which are fed through the internally hollow guide system 1 as far as the bendable region 9 and are preferably secured in its proximal region.

By turning the handwheel 19 accordingly, a traction force can be applied to at least one of the two tension cables, causing the bendable region 9 to assume the appropriate curvature in measured doses so that the guide system 1 can be fed through the bend of the aorta in a defined manner together with the cartridge unit 4.

As also illustrated in Figure 6, the lever 20 connected to the handle 13.1 acts via fine toothing 28.1 on the tube 28, enabling it to be manipulated via the operating elements 2 and/or 3 to permit the sequential release of the anchoring support 10.

Claims

1. Catheter for the transvascular implantation of heart valve prostheses with a self-expanding anchoring support, whereby the heart valve prosthesis together with the anchoring support are temporarily accommodated in a cartridge unit in a collapsed state during the implantation;

the cartridge unit can be attached to a guide system by its proximal end and the guide system has a bendable region enabling it to be fed through an aorta, characterised in that

operating elements (2, 3) are run through the internally hollow guide system (1) as far as the cartridge unit (4) in order to move parts (5, 6, 7) of the cartridge unit (4) radially about its longitudinal axis and/or laterally in the proximal and distal direction to permit a sequential release of individual parts of the anchoring support (10) together with the heart valve prosthesis.

2. Catheter as claimed in claim 1, characterised in that operating elements are provided on the bendable region (9) of the guide system (1) which act in a specific manner to influence its curvature.

3. Catheter as claimed in claim 1 or 2, characterised in that the bendable region (9) is provided in the form of a link chain with individual joints (9.2).

4. Catheter as claimed in one of the preceding claims, characterised in that the individual joints (9.2) positively engage respectively in adjacent links (9.1).

5. Catheter as claimed in one of the preceding claims, characterised in that the operating elements are provided in the form of tension means acting on the bendable region (9).

6. Catheter as claimed in one of the preceding claims, characterised in that a liquid coolant is circulated through the interior of the guide system (1) as far as the cartridge unit (4).

7. Catheter as claimed in claim 6, characterised in that the guide system (1) is designed so that it is liquid-proof.

8. Catheter as claimed in one of the preceding claims, characterised in that the cartridge unit (4)is provided with several sleeve-shaped elements (5, 6, 7) telescopically engaging in one another, between which the anchoring support (10) and heart valve prosthesis are enclosed, clamped in a collapsed state, until the implantation.

9. Catheter as claimed in one of the preceding claims, characterised in that the anchoring support (10) is also held secured by the distal end on the cartridge unit (4) incorporating the guide system (1) by means of anchoring elements (8) mounted on a sleeve-shaped element (6) of the cartridge unit (4) when, due to radial and/or lateral movements of other elements (5, 6 or 7) of the cartridge unit (4), parts of the anchoring support (10) incorporating the heart valve prosthesis are unfolded so that the heart valve prosthesis can be checked to ensure that it is functioning.

10. Catheter as claimed in one of the preceding claims, characterised in that a guide wire is fed through the

interior of the catheter.

11. Catheter as claimed in one of the preceding claims, characterised in that marker elements which absorb X-radiation are provided on the guide system (1) and/or the cartridge unit (4).

12. Catheter as claimed in one of the preceding claims, characterised in that a screen filter is attached to and radially surrounds the guide system (1).

13. Catheter as claimed in one of the preceding claims, characterised in that a balloon is disposed in the interior of the guide system (1) of the cartridge unit (4) or can be fed through the interior of the guide system (1) as far as the anchoring support (10) to be expanded.

14. Catheter as claimed in one of the preceding claims, characterised in that the operating elements, tension and compression means fed through the interior of the guide system (1) can be manipulated by a manipulating part (13).

15. Catheter as claimed in claim 14, characterised in that the manipulating part is provided in the form of a handle with control elements.

16. Catheter as claimed in one of the preceding claims, characterised in that the operating elements (2, 3) which are run to sleeve-shaped elements (6, 7) of the cartridge unit (4) are provided in the form of a length of compression spring.

INTERNATIONAL SEARCH REPORT

International application No
PCT/DE2006/000056

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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